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BIG LAKE, STEARNS COUNTY, MINNESOTA

Pacific Northwest Environmental Research Laboratories

Prepared for:

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

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REPORT

ON

BIG LAKE

STEARNS COUNTY

MINNESOTA

EPA REGION V

WORKING PAPER No. 124

WITH THE COOPERATION OF THE

MINNESOTA POLLUTION CONTROL AGENCY

AND THE

MINNESOTA NATIONAL GUARD

JULY, 1975

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS*

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

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* The lake discussed in this report was included in the National Eutrophication Survey as a water body of interest to the Minnesota Pollution Control Agency. Tributaries and nutrient sources were not sampled, and this report relates only to the data obtained from lake sampling.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

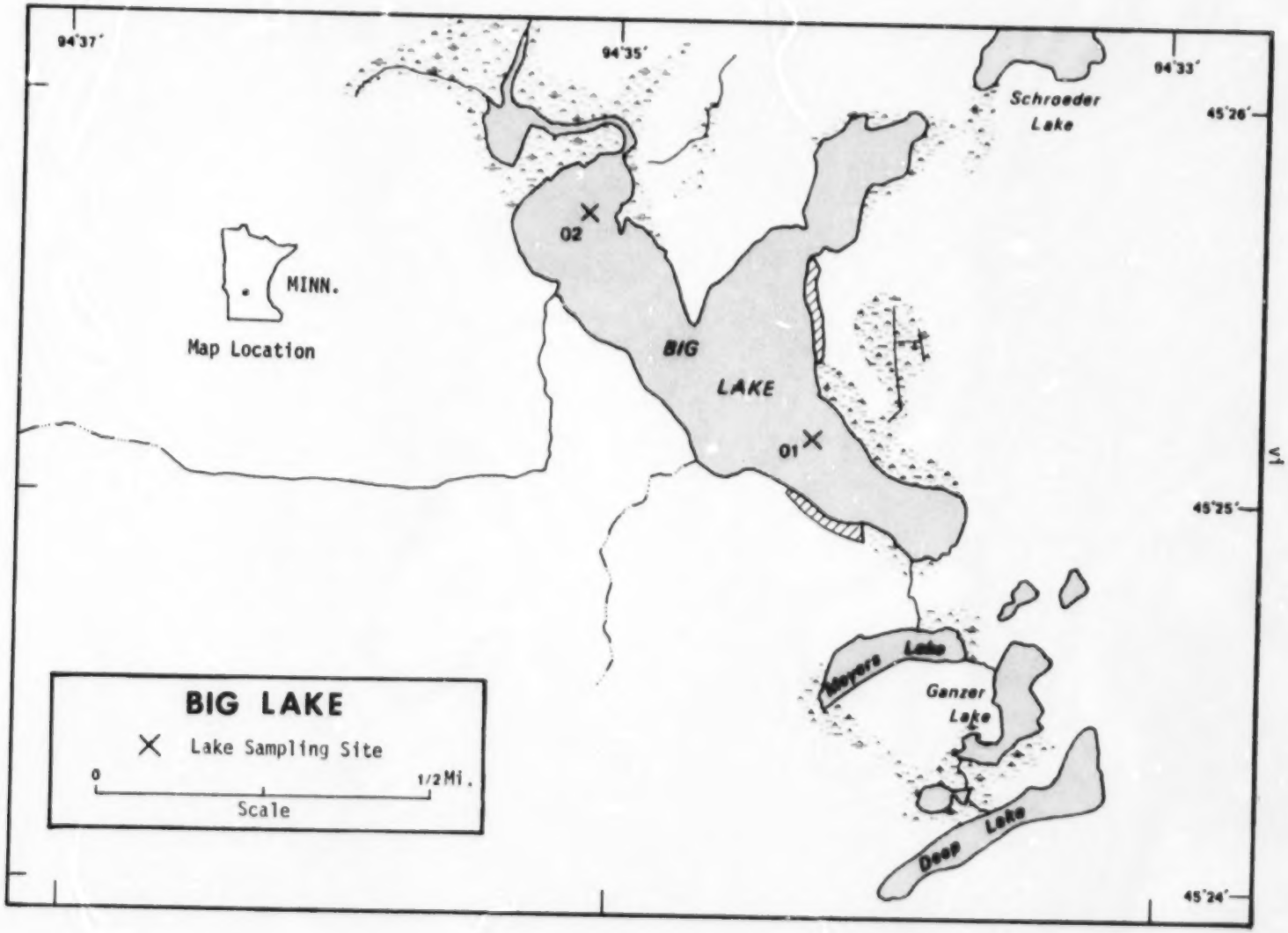
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MINNESOTA

LAKE NAME	COUNTY
Albert Lea	Freeborn
Andrusia	Beltrami
Badger	Polk
Bartlett	Koochiching
Bear	Freeborn
Bemidji	Beltrami
Big	Stearns
Big Stone	Big Stone, MN; Roberts, Grant, SD
Birch	Cass
Blackduck	Beltrami
Blackhoof	Crow Wing
Budd	Martin
Buffalo	Wright
Calhoun	Hennepin
Carlos	Douglas
Carrigan	Wright
Cass	Beltrami, Cass
Clearwater	Wright, Stearns
Cokato	Wright
Cranberry	Crow Wing
Darling	Douglas
Elbow	St. Louis
Embarass	St. Louis
Fall	Lake
Forest	Washington
Green	Kandiyohi
Gull	Cass
Heron	Jackson
Leech	Cass
Le Homme Dieu	Douglas
Lily	Blue Earth
Little	Grant
Lost	St. Louis

LAKE NAME	COUNTY
Madison	Blue Earth
Malmedal	Pope
Mashkenode	St. Louis
McQuade	St. Louis
Minnetonka	Hennepin
Minnewaska	Pope
Mud	Itasca
Nest	Kandiyohi
Pelican	St. Louis
Pepin	Goodhue, Wabasha, MN; Pierce, Pepin, WI
Rabbit	Crow Wing
Sakatah	Le Sueur
Shagawa	St. Louis
Silver	McLeod
Six Mile	St. Louis
Spring	Washington, Dakota
St. Croix	Washington, MN; St. Croix, Pierce, WI
St. Louis Bay	St. Louis, MN; Douglas, WI
Superior Bay	St. Louis, MN; Douglas, WI
Swan	Itasca
Trace	Todd
Trout	Itasca
Wagonga	Kandiyohi
Wallmark	Chisago
White Bear	Washington
Winona	Douglas
Wolf	Beltrami, Hubbard
Woodcock	Kandiyohi
Zumbro	Olmstead, Wabasha


94°37'
94°35'
94°33'
45°26'
45°25'
45°24'
Schroeder Lake
02
01
BIG LAKE
MINN.
Map Location
Ganzer Lake
Deep Lake
BIG LAKE
Lake Sampling Site
0
1/2 Mi.
Scale

BIG LAKE

STORET NO. 2708

I. INTRODUCTION

Big Lake was included in the National Eutrophication Survey as a water body of interest to the Minnesota Pollution Control Agency. Tributaries were not sampled, and nutrient sources were not evaluated. Therefore, this report relates only to the lake sampling data.

II. CONCLUSIONS

A. Trophic Condition:

Survey data indicate Big Lake is eutrophic. Of the 80 Minnesota lakes sampled, 24 had less mean total phosphorus, 33 had less and one the same mean dissolved phosphorus, 51 had less mean inorganic nitrogen, 25 had less mean chlorophyll a, and 22 had greater mean Secchi disc transparency. Dissolved oxygen was depleted at 25 feet at both sampling stations in July and essentially was depleted at 27 feet at station 1 in August, 1972.

Survey limnologists observed an algal bloom in progress in July, and blue-green algae were dominant in both phytoplankton samples.

B. Rate-Limiting Nutrient:

Big Lake was not sampled in the fall, and no algal assay sample was taken. However, the lake data indicate nitrogen limitation in July (N/P ratio = 7/1) but phosphorus limitation in August (N/P = 24/1).

III. LAKE CHARACTERISTICS

A. Morphometry*:

1. Surface area: 403 acres.
2. Mean depth: 11.9 feet.
3. Maximum depth: 42 feet.
4. Volume: 4,796 acre-feet.

B. Precipitation**:

1. Year of sampling: 26.7 inches.
2. Mean annual: 23.8 inches.

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* MN Dept. Nat. Resources lake survey map (1971); mean depth by random-dot method.
** See Working Paper No. 1, "Survey Methods, 1972".

IV. LAKE WATER QUALITY SUMMARY

Big Lake was sampled two times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from two or more depths at each station (see map, page vi). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration, and a similar sample was collected for chlorophyll a analysis. The lake was not sampled in the fall, and no sample was taken for algal assays. The maximum depth sampled were 27 feet at station 1 and 25 feet at station 2.

The results obtained are presented in full in Appendix A, and are summarized in the following table.

A. Physical and chemical characteristics:

Parameter	1st Sample (07/02/72) Mean	1st Sample (07/02/72) Range	2nd Sample (08/29/72) Mean	2nd Sample (08/29/72) Range
Temperature (Cent.)	18.7	14.0 - 24.0	18.7	12.8 - 22.3
Dissolved oxygen (mg/l)	4.8	0.0 - 11.7	6.3	0.4 - 10.4
Conductivity (μmhos)	348	320 - 380	330	330 - 420
pH (units)	7.8	7.3 - 8.3	8.0	7.1 - 8.4
Alkalinity (mg/l)	169	159 - 174	172	156 - 240
Total P (mg/l)	0.030	0.020 - 0.049	0.050	0.016 - 0.250
Dissolved P (mg/l)	0.012	0.009 - 0.017	0.021	0.010 - 0.102
NO_2 + NO_3 (mg/l)	0.040	0.030 - 0.040	0.070	0.050 - 0.100
Ammonia (mg/l)	0.040	0.020 - 0.060	0.439	0.080 - 2.480
Secchi disc (inches)	76	76 - 76	63	54 - 72

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
07/02/72	1. Anabaena	1,537
	2. Microcystis	1,121
	3. Melosira	850
	4. Oocystis	488
	5. Chroococcus	398
	Other genera	1,682
	Total	6,076
08/29/72	1. Anabaena	1,628
	2. Microcystis	1,031
	3. Dinobryon	416
	4. Fragilaria	289
	5. Melosira	271
	Other genera	705
	Total	4,340

V. LITERATURE REVIEWED

Anonymous, 1974. Wastewater disposal facilities inventory. MPCA, Minneapolis.

VI. APPENDIX

APPENDIX A

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/10/30

270801
45 25 07.0 094 34 20.0
BIG LAKE
27 MINNESOTA

11EPALES 2111202
3 0022 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/02	18 30	0000	24.0	11.7	76	320	8.30	173	0.040	0.060	0.020	0.009
	18 30	0015	19.0	2.3		370	7.40					
	18 30	0020	14.0	0.1				171	0.040	0.040	0.049	0.017
72/08/29	15 45	0000			72	330	8.40	159	0.050	0.090	0.019	0.010
	15 45	0004	22.3	10.4		363	8.42	156	0.060	0.080	0.016	0.011
	15 45	0015	19.5	5.8		345	7.90	163	0.050	0.100	0.017	0.012
	15 45	0021	17.5	5.4		360	7.40	177	0.100	0.520	0.035	0.016
	15 45	0027	12.4	5.4		420	7.10	240	0.060	2.480	0.250	0.107

7.

DATE FROM TO	TIME OF DAY	DEPTH FEET	32211 CHLRPHYL A UG/L
72/07/02	18 30	0000	24.4J
72/08/29	15 45	0004	11.4J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/10/30

270802
48 25 40.0 094 35 06.0
BIG LAKE
27 MINNESOTA

11EPALES 2111202
3 0029 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/02	18 55	0000	24.0	10.0	76	320	8.10	174	0.030	0.040	0.029	0.012
	18 55	0025	13.5	1.0		380	7.30	159	0.030	0.020	0.024	0.013
72/08/29	16 05	0000			54	334	8.35	164	0.060	0.080	0.021	0.012
	16 05	0004	20.4	8.2		335	8.30	160	0.080	0.080	0.021	0.011
	16 05	0024	14.5	6.4		349	8.00	158	0.080	0.080	0.023	0.011

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/02	18 55	0000	8.5J
72/08/29	16 05	0000	6.4J

J VALUE KNOWN TO BE IN ERROR